ISC Standards and Calibration Laboratories

Overview: The Standards and Calibration Laboratories (S&CL) provide Institutional calibration services traceable to the National Institute of Standards and Technology (NIST). The S&CL consists of Reference Standards Laboratories and Calibration Laboratories, providing calibration support for Electrical and Physical/Mechanical measuring and test equipment (MTE).

The Physical/Mechanical laboratories are located at KSC, in the Central Instrumentation Facility (CIF), and the Electrical laboratories are located at Patrick Air Force Base (PAFB). Additionally, a subset of Physical/Mechanical work is performed at Cape Canaveral Air Force Station (CCAFS).

Today's tour consists of an oral presentation on the facilities at PAFB and CCAFS, and a walk-through of the Physical/Mechanical laboratories here in the CIF. Space is limited in the labs. Please do not touch equipment and be careful of bumping it.

During the tour, certain rooms will be bypassed. Those rooms are either not part of the S&CL or are office space.

Photography is allowed. Please be mindful of photographing laboratory workers.

1. Electrical Standards and Calibration located at PAFB:

The S&CL Electrical labs are co-located with the USAF Precision Measuring and Equipment Laboratory / Electrical (PMEL/E) at PAFB. The S&CL Electrical labs provide broad-based calibration support for electrical MTE used at KSC; the lab capabilities include:

- **Direct Current (DC) capability**
  - DC voltage, capability includes a Josephson Voltage System, known as a "J-Volt", intrinsic voltage standard
  - DC voltage ratio
  - DC current
  - DC resistance
- **Alternating Current (AC) capability**
  - AC voltage
  - AC voltage ratio
  - AC current
  - AC phase – measure and source
  - Capacitance
  - Inductance
  - Frequency
  - Magnetic field strength
- **Radio Frequency (RF) and Microwave capability**
  - RF and microwave power measurement (Continuous Wave)

    - RF and microwave attenuation
    - Network analysis (scattering parameters, group delay, phase)

- **Photometric, Radiometric, and Fiber Optic capability**
    - Luminous intensity
    - Illuminance
    - Luminance
    - Spectral radiometry detector spectral response
    - Fiber optic power
    - Fiber optic attenuation
    - Fiber optic wavelength

- **Miscellaneous capability**
    - Sound pressure level
    - Microphone sensitivity
    - Vibration pickup sensitivity

2. Physical/Mechanical calibrations performed at CCAFS, where CIF capabilities are limited:

While the S&CL Physical/Mechanical labs are located here in the CIF, some calibrations are performed at the Precision Measuring and Equipment Laboratory / Physical (PMEL/P) at CCAFS. The work performed at CCAFS is a very small portion of the physical/mechanical workload, primarily limited to gas flow calibrations outside the capabilities here in the CIF. The PMEL/P capabilities used by S&CL include:

- **Gas Flow Calibration** (>30 liters per minute)
    - Flow rates up to 250 cubic feet per minute
        - Using sonic nozzles and laminar flow elements
        - Media: Air, helium, nitrogen
    - Flow rates up to approximately 2000 cubic feet per minute
        - Using laminar flow elements
        - Media: Air
- **Air velocity calibration**
    - Method: Bench top wind tunnel
    - Range: Up to approximately 8000 feet per minute

Start of the walking tour

Physical/Mechanical Standards and Calibration – Located in the CIF

Temperature Standards / Helium Leak Standards

- **Temperature Standards** (fixed-point temperature references): Used for characterization of platinum resistance thermometers; fixed points are:
    - Boiling point of liquid nitrogen
    - Mercury triple point
    - Water triple point
    - Gallium Melt point
    - Indium Freeze point
    - Tin freeze point
    - Zinc freeze point
    - Aluminum freeze point
    - Silver freeze point
- **Helium Leak Standards**: Consists of standard leaks and leak rate comparator
    - NIST-calibrated standard leaks are compared to customer leaks
    - Can characterize test leaks over a temperature range of 15°C to 35 °C
    - Leak range: 9.6×10^{-11} to 1.2×10^{-13} mole per second

Pressure and Vacuum Standards

- **Vacuum Standards**: Vacuum system incorporates multiple technologies to cover the measurement range,
    - Spinning rotor gage
    - Stable ion gage
    - Deadweight piston gage
    - Capacitance diaphragm gages
    - Overall range of system: 1×10^{-6} Torr to 5000 Torr
    - Media: Nitrogen
- **Pressure Standards**
    - Dead weight piston gages: An array of dead weight piston gages provide pneumatic and hydraulic capability across an extended range of pressures
        - Pneumatic (nitrogen) range: 0 to 14,500 PSI
        - Hydraulic (oil) range: 0 to 72,500 PSI

Flow Standards, Pressure Standards & Calibration

- **Gas Flow Standards**
    - Gravimetric mass flow calibrator:
        - Range: 10 cubic centimeters per minute to 10 liters per minute
            - Extended range of 100 liters per minute through comparisons with transfer standards

    - Media: Air, helium, nitrogen
- **Pressure Standards and Calibration**
    - Mercury manometer (pressure standards lab)
        - Range: 0 to 32.5 PSI
        - Media: Nitrogen
    - Automated dead weight piston gage (pressure calibration lab)
        - Pneumatic (nitrogen) range: 0 to14,500 PSI
        - Hydraulic (water) range: 0 to 30,000 PSI

Dimensional / Optics Standards and Calibration, Mass Calibration

NOTE: Room temperature maintained at 20°C (68°F)

- **Dimensional Calibration, capabilities include;**
    - Length measurement
        - Range: Up to 39 inch with length machines
    - Diameter measurement
        - Internal Diameter (ID) Range: 0.2 to 16 inch
        - Outside Diameter (OD) Range: up to 1.5 inch
    - Flatness measurement
        - Range: Optical planes up to 6 inch
            - Surface plates up to 10 foot
    - Angle measurement **(no limitation to angles that can be measured)**
- **Dimensional Standards, capabilities include;**
    - Length measurement
        - Gage block measurement, with a range of: 0.01 to 20 inch
        - Overall range: Up to 39 inch with length machines
    - Surface roughness measurement
        - Range: 2 to 160 microinch Roughness average
    - Flatness measurement
        - Range: Optical planes up to 6 inch
    - Angle measurement **(no limitation to angles that can be measured)**
- **Mass Calibration**
    - Method: Direct comparison to standard masses using an array of mass comparators and balances
- **Optics Standards and Calibration**
    - Measurement system: short-range calibrator
    - Calibration of optical tooling
    - Additional length measurement capability for the Standards and Calibration labs
        - 50 foot range for steel-tape measurement

Mass Standards – This room is also maintained at 20°C (68°F)

NOTE: Due to the temperature sensitivity of the room, no tour entry is permitted. The door will be opened for a brief look within.

- Method: Direct comparison to standard masses using an array of mass comparators and balances
- Comparison Range: 1 milligram to 30 kilogram
- Most balances and comparators in this lab are on vibration mitigation tables that are isolated from the building structure.

Pressure Calibration and Precision Cleaning

- **Pressure Calibration**
    - Method: Comparison to digital pressure gages and pressure controllers
        - Pneumatic (nitrogen) range: 0 to 1,500 PSI
        - Hydraulic (water) range: 0 to 40,000 PSI
- **Precision Cleaning**

NOTE: The precision cleaning room is a class 100,000 clean room so no tour entry is permitted.

    - Cleaning of pressure gages and flow meters
        - Media: CFC 113
        - Hydrocarbon cleaning: Level A (< 1 milligram per 100 milliliter)
        - Particulate cleaning: Level 50 (no particles > 50 micron)

Force Standards and Calibration, IR Temperature Calibration

- **Force Standards and Calibration**
    - Comparison to standard load cells
        - Range: up to 100,000 pounds force
    - Comparison to dead weight
        - Range: up to 1,000 pounds force
            - Torque cell calibration up to 4,000 foot-pounds
- **Infrared (IR) Temperature Calibration**
    - Method: Comparison to black body sources
    - Range: 35°C to 1,000°C

Gas and Chemical Calibration

- Calibration of gas detectors using standard gases
    - 10 test gases, including oxygen
- Calibration of conductivity and pH meters using standard solutions
- Calibration of halogen leak detectors
    - Range: 0.5 to 5 ounce/year

Temperature and Dew Point / Humidity Calibration

- Temperature
    - Method: Comparison to reference thermometers using temperature baths
    - Range: -50°C to 600°C
- Humidity and Dew Point

    - Method: Dew point and humidity generators
    - Range: -90°C dew/frost point to >90% relative humidity

Torque, Vacuum, Particle Counter, and Flow Calibration

- **Torque Calibration**
    - Tested using torque wrench calibration systems **(torque transducers)**
    - Range: 5 inch-ounce to 4,000 foot-pound
- **Vacuum Calibration**
    - Comparison to capacitance diaphragm gages
    - Range: $4x10^{-6}$ Torr to 760 Torr
- **Particle Counter Calibration**
    - Testing performed using 0.5 micron and 5.0 micron particles
- **Gas Flow Calibration**
    - Range: 10 cubic centimeters per minute to 30 liters per minute
    - Media: Air, helium, nitrogen